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Instructional Enhancement in Elementary Patterns and Algebra

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ABSTRACT:
The main objective of this research was to assess the learners' competencies in Elementary Patterns and Algebra, the results of which served as basis for the proposed instructional enhancement for teachers. Using the descriptive method of investigation, the research involved the Grades IV-VI pupils from the three (3) schools in District I, Division of City Schools, Manila, Philippines for the School Year 2018-2019. To assess the competencies of the learners in the said component of Mathematics, a researcher made test was developed based on the learning competencies outlined in the K to 12 Curriculum Guide in Grades IV-VI Mathematics. Validity and reliability tests were performed accordingly with the help of subject matter experts and statisticians. After identifying the performance of the respondents in the 3 grade levels, the results were then analyzed followed by the crafting of an instructional enhancement in Elementary Patterns and Algebra. Results revealed that the majority of the competencies were rated "Least Mastered" thereby confirming the need to further enhance the instruction of the teachers handling the said subject area.

Keywords: Assessment, Patterns and Algebra, Elementary, Learners, Curricular Enhancement

INTRODUCTION

"William Glasser, an American psychiatrist, once remarked: "If you improve education by teaching for competence, eliminating, schooling, and connecting with learners, the test scores will improve." His words vividly explain the vital role of learning anchored in competencies." [1]. Undoubtedly, when the teachers focus on their learners' competencies, the learners are more empowered to produce meaningful outcomes. Assessment of the learners' progression in the lessons like Patterns and Algebra is imperative to pinpoint the strengths and weaknesses of the learners resulting to appropriate academic interventions including instructional enhancement for teachers. "Indeed, teaching and learning are important elements of the educational process. The teacher uses different approaches and strategies to teach their learners to promote active learning. Meanwhile, at the heart of the teaching-learning process is the assessment. Assessment is a key component of learning because it helps pupils learn. When learners are able to see how they are doing in a class, they are able to determine whether or not they understand the course materials. Assessment can also help motivate learners. If learners know they are doing poorly, they may begin to work harder [2]. As stipulated in the study of Hauser 2015 according to Popham, Pellegrino, Broadfoot and Black, and Greentein, the term "assessment" encompasses a variety of methods and practices to assess student knowledge. Assessment includes but are not limited to classroom assessment, high-stakes assessments, portfolio assessments, and common assessments administered across more than one classroom. It focuses not only on the definition of assessment but also on the process. [3]. Assessment results are used for a variety of purposes. A single assessment result does not always inform the stakeholders on the learning process or the effectiveness of a program [4]. There are both internal and external factors that can have an impact on how students perform on any given assessment which can present challenges to

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the interpretation of the assessment results [5]. A testing day in K-12 mathematics classroom typically consists of students scribbling down what they can recall from their notes and homework. Learners usually replicate the procedures they learned in class on a test. Assessments should measure learners' conceptual understanding in addition to their procedural understanding. Research on alternative assessments is crucial in order to discover effective ways to measure procedural and conceptual understanding. According to the National Assessment of Educational Process, conceptual understanding pertains to the learners' ability to identify and apply principles using varied representations of concepts 2003 while the procedural understanding manifests when students are able to complete a mathematical procedure. The National Council of Teachers of Mathematics (NCTM) encourages further research on effective assessments that achieve accurate measurement of mathematical knowledge of procedures and concepts. NCTM recognizes the importance of research on assessments in order to find assessments that are valid and reliable when measuring the Standards of Mathematical Practice [6]. Certainly, Mathematics teachers need alternative assessments in order to effectively support student learning [7]. With these realities, a research that will assess the competencies of the learners in Elementary Mathematics particularly in Patterns and Algebra towards instructional enhancement has become truly imperative.

CONCEPTUAL AND THEORETICAL FRAMEWORK

"This study was anchored on the theory of *Discovery Learning. Discovery Learnin*g [8] supports the idea that students learn when they make use of personal experiences to discover facts, relationships, and concepts [9]. It is also characterized by having fewer teacher explanations, least possible teacher guidance and multiple solutions on solving problems. It can be applied in Patterns and Algebra specifically in solving algebraic expressions, algebraic equations and solving equations. In *Discovery Learning*, instead of using long method, one can use the short method. Patterns and Algebra as a strand deals with patterns, relationships, and changes among shapes and quantities. It includes the use of algebraic notations and symbols, equations, and most importantly, functions, to represent and analyze relationships [10]. The Patterns, Functions and Algebra at Grades IV-VI levels lean heavily on making generalizations and in using a variety of representations to illustrate patterns, relationships and phenomena such as rates of change. There is an increased emphasis on establishing relations between sets and numbers, generalizing procedures and results, as well as using modeling techniques to investigate quantitative changes [11]. Mathematics is one subject that pervades life at any age and in any circumstances. Thus, its value goes beyond the classroom and the school. Mathematics as a school subject, therefore, must be learned comprehensively and with much depth through exploration. The achievement scores, whether in local or international examination, are means to measure comprehension on different subject areas and highlight students' overall academic performance. The twin goals of mathematics in the basic education level, K-10, are Critical Thinking and Problem Solving. Critical thinking, according to Scriven and Paul [12] is the intellectual disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. On the other hand, according to Polya [13], mathematical problem solving is finding a way around a difficulty, around an obstacle, and finding a solution to a problem that is unknown. These two goals are to be achieved with an organized and rigorous curriculum

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content, a well-defined set of high-level skills and processes, desirable values and attitudes, and appropriate tools, taking into account the different contexts of Filipino learners. There are five content areas in the curriculum, as adopted from the framework prepared by MATHTED & SEI 2010: Numbers and Number Sense, Measurement, Patterns and Algebra, and Probability and Statistics. The specific skills and processes to be developed consisted of the following: knowing and understanding; estimating, computing and solving; visualizing and modelling; representing and communicating; conjecturing, reasoning, proving and decision-making; and applying and connecting. Educators handling Mathematics recognize that the use of appropriate tools is necessary in teaching mathematics. These include manipulative objects, measuring devices, calculators and computers, smart phones and tablet PCs, and the Internet. They define context as a locale, situation, or set of conditions of Filipino learners that may influence their study and use of mathematics to develop critical thinking and problem-solving skills. Contexts refer to beliefs, environment, language and culture that include tradition and practices, as well as the learner's prior knowledge and experiences [14]. Figure 1 presents the systematic procedures that were observed in the conduct of the study. Initially, the researcher determined the status of the learners' competencies in Elementary Patterns and Algebra focusing on each of the grade levels namely Grades IV, V, and VI. For Grade IV, competencies such as 1) Determining the missing term/s in a sequence of numbers and 2) Finding the missing number in an equation involving properties of operations were specifically assessed while 1) Sequencing; 2) Solving simple equations involving one or more operations; and 3) Solving problems were examined in Grade V. Lastly, competencies such as 1) Writing rules for sequences; 2) Translating algebraic expressions; 3) Translating algebraic equations; and 4) Solving equations in Grade VI were assessed accordingly. To examine the said competencies, an assessment test for each of the following grade levels in Patterns and Algebra was administered to the respondents.

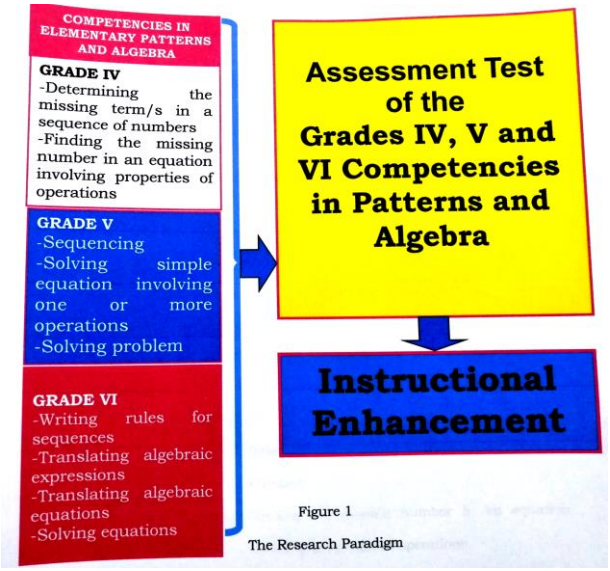

Figure 1
The Research Paradigm

STATEMENT OF THE PROBLEM

This study aimed to assess the elementary learners' competencies in Patterns and Algebra for Grades IV-VI, the results of which served as basis for instructional enhancement.

Specifically, it sought answers to the following questions:

1. What are the existing instructional strategies in Patterns and Algebra employed by the Elementary teachers in the following grade level
   - 1.1 Grade IV
   - 1.2 Grade V
   - 1.3 Grade VI?

2. What is the performance level of the learners in various competencies in Patterns and Algebra for each of the following grade levels:

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2.1 Grade IV
- 2.1.1 Determining the missing term/s in a sequence of numbers
- 2.1.2 Finding the missing number in an equation involving properties of operations

2.2 Grade V
- 2.2.1 Sequencing
- 2.2.2 Solving simple equation involving one or more operations
- 2.2.3 Solving problems

2.3 Grade VI
- 2.3.1 Writing rules for sequences
- 2.3.2 Translating algebraic expressions
- 2.3.3 Translating algebraic equations
- 2.3.4 Solving equations?

3. Which competencies are mastered and least mastered by the learners?

4. What instructional enhancement for teachers may be proposed based on the findings?

LITERATURE REVIEW

In the elementary level, Patterns and Algebra is embedded in the K-12 Curriculum in Grades IV, V and VI. In most countries like Philippines, Algebra is introduced in the Junior High School. This occurred because of a historical reason: Algebra was invented long after the invention of arithmetic as cited by Carraher et al. [15] in the study of Apsari [16]. As mentioned in the study of Kierran [17], and Dekker and Dolk [18], algebraic thinking is the ability to focus on relations between the letters, numbers and signs and ability to develop models and language of algebra. In addition, they developed algebraic thinking: (1) generalize and reason within algebraic structure, (2) develop mental models which refers to the learners' construction of a possible strategy to work within algebra related tasks, (3) construct fundamental algebraic ideas, (4) observe, formulate and visualized pattern and (5) solve Algebra-related problems [19]. In addition, it was stated by Brawner (2012) [20] in the study of Apsari [21] that Algebra is acknowledged as a gatekeeper of all high school mathematics. Numbers are not only for counting nor for measuring. They are also used to identify order and sequences. One good example is the use of numbers for identifying locations and one's addresses. Most addresses follow a certain process or sequence [22]. Moreover, the learners will have a wide range of knowledge in imagery on Patterns and Algebra which include the next number, letter and figure and what operations to be applied first or last. According to Apsari [23], the results denoted that exploration in patterns can support the learners in developing their sense of structure which is remarkably influence the learners' algebraic thinking. In addition, they include four strands in algebra such as patterns and formula, restriction, function and language. Moreover, Don [24] emphasized in the study of Apsari [25] that the problem encountered by learners in Patterns and Algebra consist of the four conceptual components which are considered the most problematic areas like the variables, algebraic expressions, algebraic equation and word problems.

Algebraic solving ability had been discussed by many educators and researchers. This contributed much as initial inputs of the researcher in the conduct of this investigation with regard to Patterns and Algebra in Elementary Mathematics specifically in Grades IV, V and VI. The emphasis on algebraic solving ability has raised issues such as how to introduce and develop algebraic solving ability in the classroom. A

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number of researchers have discussed different methods and perspectives to generate algebraic solving ability among the students. Holbrook [26] adapted the Wheel of Fortune television game show to introduce and develop the seventh, eighth and ninth grades learners' algebraic solving ability especially in solving first-degree equation in one variable. Learners found the game as exacting as the television version. They were able to solve most of the equations mentally, without using pencil and paper. This activity engaged learners in solving equation by using formal and informal methods and encouraged mental computation and estimation. It also enhanced learners' confidence, algebraic reasoning, algebraic solving ability and encouraged mathematical communication. The game was also an excellent opportunity to assess informally learners' ability to solve algebraic problem. Edwards [27] experienced that in the early middle school, the most difficult aspect of developing algebraic solving ability among the students is the meaningful acquisition of algebraic notation, the concept of variable, function and properties of numbers. These four basic concepts had been highlighted as a big idea of algebra and should be developed in order to build a strong foundation of algebraic solving ability in classroom. Smith and Philips [28] presented student work which illustrated the range, depth and character of students' algebraic solving ability in judging about equivalence. They highlighted a few of algebraic skills which they viewed as a starter set of competencies that can served as a solid foundation for developing more advanced algebraic solving ability, these included: a) identify the quantities that vary in problem situations and describe how the variables are related; b) describe the rates of change of the relationship that was presented in table, graph or symbolic expressions; and c) understand the equivalence of algebraic expressions in multiple ways. The finding showed that the students knew different ways to think about equivalence, such as: a) substitute particular values for x and compare the results; b) generate and compare tables of values; and c) simply inspect the expressions. The abovementioned literature can serve as a valuable reference in the researcher's attempt to determine the strengths and weaknesses of the elementary learners of Patterns and Algebra as well as to explain their overall performance in the said subject. Obviously, there were limited investigations along this topic in the Philippines.

In order for learners to develop their innate number sense in determining the missing term/s in a sequence of numbers and a working knowledge of the above concepts, they must have a great variety of interactions with their environment, exploring and manipulating, comparing, arranging and rearranging real objects and sets of objects. Many of these types of interactions and experiences occur incidentally for sighted children, but the blind child is at great risk for missing valuable and relevant incidental information. Therefore, it is critical that teachers and parents provide both structured and informal opportunities to handle and explore, note likenesses and differences, match, group and classify, order, and experience other relationships with real objects to prepare them for understanding the same relationships with numbers. The development of classification concepts involves several sequential stages: (a) discriminating between same and different (note: if a child has difficulty with the dichotomy of same/different, the dichotomy of same/not same may be more effective to begin with); attention should be called to the critical features of objects and their attributes; (b) matching, grouping and categorizing according to specific criteria; and (c) classifying according to a variety of dimensions [29]. When teachers use appropriate strategies in Patterns and

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Algebra, the learners can excel in determining the missing term/s in a sequence of numbers.

Solving equations is the bread and butter of mathematics. Adding, subtracting, multiplying and dividing numbers are necessary elements of computation, but the real magic lies in finding the missing number in an equation involving properties of operations given sufficient numerical information to carry this out. Equations contain variables, which are letters or other non-numerical symbols representing values it is up to you to determine. The complexity and depth of understanding required to solve equations ranges from basic arithmetic to higher-level calculus, but finding the missing number is the goal every time [30]. The traditional pedagogy applied by most teachers in the elementary level in the teaching of Patterns and Algebra may contribute to the lack of mastery with regard to this competency of the learners. Hence, instructional enhancement may be needed to address the competencies that are said to be weak.

A sequence is a set of numbers written in a special order by the application of a definite rule. Each number in the sequence is called a term [31]. In addition, a sequence refers to set letters, numbers and signs that are in order. Each number in the sequence is called a term (or sometimes "element" or "member"). Meanwhile, in the sequencing, the learners should be knowledgeable in identifying the patterns of object arrangement, predict the next term of a regular pattern, generalize the strategy to predict any term in a pattern and evaluate the relation between the numbers [32]. In line with this, sequencing directly forces the learners to look on the relation between numbers without any support. However, it was noticed that the learners still do not perceive a clear image about the use of certain letters and signs in different situations. Moreover, some learners find it confusing because they are not familiar with algebraic language.

Order of operations can be frustrating to teach, but it does not have to be. There is no question that this is an extremely challenging topic for elementary learners. Fortunately, there are loads of strategies for teaching order of operations that are both fun and effective. One reason why the kids struggle with this concept is that there are so many rules to learn and follow. Even worse, rules that appear to be simple often prove to be deceptively complex. For example, most kids can easily remember that multiplication and division are always performed before addition and subtraction, especially after they learn to follow the order described by "PEMDAS/GEMDAS." However, they tend to get stuck when an equation includes both multiplication and division. Most kids automatically multiply before dividing, but order of operations tells us to perform the operation that comes first when reading the problem from left to right. Another reason learners struggle is that even when they understand how to use order of operations correctly, they do not apply the rules systematically. Because the problems look easy, learners try to rely on mental math alone to solve them. This may work with the easy problems, but mental math isn't effective with more complex problems that include multiple operations, parentheses, exponents [33]. When the learners are trained in simple equations accordingly, they tend to display skills in solving one or more equations confidently. However, it seems that a few pieces of literature about specific strategies that enhance this competency exist. Hence, an empirical study may shed light on this issue.

Teaching mathematics to children can be extremely challenging, especially when it comes to problem solving. This is when learners really have a hard time. Problem-solving tools are the key to enhance the problem-solving proficiency in learners.

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Using teaching strategies to get students to use the right solving formats is just as important as getting them to get the correct answer. Teach learners that there is more than one way to get an answer, and this will help them to expand their thinking [34]. The finding a pattern strategy is when students look for patterns in order to solve the problem. Learners would read the problem, then look for any numbers, items, or series of events that are repeated throughout that problem. Young learners usually discover this strategy when they are learning their multiplication tables. They notice that 2 x 4 is the same as 4 x 2, and so on. They also notice the patterns when they look at a hundred chart. They can see that one column has all zeros, etc. To teach learners the finding a pattern strategy, you can start by putting students into cooperative learning groups [35]. When solving algebraic problems, students will need to create generalized algebraic equations for each part of the question. Learners will then need to perform appropriate substitutions and solve the resulting equation. To do this efficiently, they will need to choose carefully and have a confident understanding of substitutions and solving equations involving fractions.

Successful math students use the concepts of algebra —patterns, relationships, functions, and symbolic representations—in constructing solutions to mathematical problems. The activities in Dice Activities for Algebraic Thinking were created to engage learners in developing fluency with the mathematical concepts of square number, square root, prime number, factorials, summation, integers, and exponential notation. The activities are designed to empower learners to analyze, represent, and make generalizations about patterns in all aspects of math and to address mathematical problems and challenges with curiosity and confidence. Dice Activities for Algebraic Thinking precedes formal work in algebra in which learners employ deductive reasoning and step-by-step procedures to balance equations. The book provides opportunities to employ inductive/intuitive cognitive strategies to solve for n, thus deepening learners' understanding of algebra and providing a foundation for further study [36].

The learners hardly recognized the importance of translating algebraic expressions as a representation of the changeable unknown which refers to the range of a value of a function [37]. Hence, an algebraic expression is a mathematical phrase that uses variables, numerals, and operation symbols [38]. In line with this, learners should know the uses of the variables and numerals as well as what operations or symbols to be performed first. Further, they should know the relationship between signs and the number. Meanwhile, as mentioned by [39].in the study of Apsari [40], there are reasons why the Indonesian learners have difficulty in learning: (1) mathematizing, (2) interpretation of the algebraic expressions, (3) application of the arithmetical operations, (4) conceptualizing the use of equal sign and (5) the use of variables.

Most of the learners failed to understand the meaning of symbols used in the algebraic equations and later incorrectly applying operation within the elements of them [41]. An algebraic equation is a mathematical sentence with an equal sign (=) which shows that two expressions on either side are equal. Common words translated as "=" are equals, is, are, were, was, is equal to, and result is [42]. In line with this, in translating the algebraic expressions, knowledge with the following becomes imperative: order of the whole numbers, application of the basic number operations to the whole number and finding of factors as well as the multiples of certain numbers. According to Apsari [43], in the case of word problems, the learners mostly failed problem solving in translating the information described in the words to the

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corresponding algebraic equations. In solving the equation 2x + 8 = 38, the first step involved is isolating the variable on one side of the equal sign, by adding or subtracting a constant as needed. In this case, 8 is subtracted from both sides to get 2x = 30. The next step is to get the variable by itself by stripping it of coefficient. Here, each side is divided by 2 to get x = 15.
In these equations, one is actually looking not for a single number but a set of numbers, that is, a range of y-values that correspond to a range of y-values to yield a solution that is a curve or a line on a graph not a single point. For example, y = 6x + 9, one can start by plugging in x-values of one's choice. It is convenient to start with 0 and work up and then down by units of 1. This gives y = 6 (0) + 9 = 9, y = 6 (1) + 9 = 15 and y = 6 (2) + 9 = 21 [44].

To solve an equation for *n*, one has to get alone on one side of the equation. The four basic properties used to solve equations are: Addition Property of Equality, Subtraction Property of Equality, Multiplication Property of Equality and Division Property of Equality. Addition Property of Equality is utilized if the same quantity is added to both sides of an equation hence the resulting equation is equivalent to the original equation while Subtraction Property of Equality is employed if the same quantity is subtracted to both sides of an equation, the resulting equation therefore, is equivalent to the original equation. Moreover, Multiplication Property of Equality can be utilized provided that the same quantity is multiplied to both sides of an equation, the resulting equation then is equivalent to the original equation. Lastly, Division Property of Equality can be used if the same quantity is divided to both sides of an equation thereby the resulting equation is equivalent to the original equation [45].

On the matter of solving problems by using a discovery model of learning, one has to follow the indicator of solving problems, such as understanding the problem, problem-solving plan, implement the plan, as well as re-examining the process and results. Only the learners who did not get the discovery learning model of problem-solving abilities look a little lower than the learners who obtained a model of discovery learning in the settlement plan, such an approach or problem-solving strategies. The strategies used tend to be less effective. In addition, learners did not get the subject themselves in this model of learning using the knowledge previously learned in Algebra and its relevant concepts in the form of mathematical models. It is covering the presence of difference in the outcome between mathematical problem-solving ability of students to obtain a model of discovery learning with models other than the Discovery Learning [46].

In those countries where learners are still developing fundamental mathematics skill, the TIMSS Numeracy assessment (designed to be administered at the fourth, fifth, or sixth grade) offers all difficult mathematics assessment. The assessment measures children's numeracy learning outcomes, including fundamental mathematical knowledge, procedures, and problem-solving strategies. It is intended to be responsive to the needs of the global education community and efforts to work towards universal learning for all learners according to TIMMS [47]. As revealed by the TIMSS, the learners are struggling when it comes to the four fundamental operations especially in problem solving. This problem is not only for an individual but for most of the learners who experience difficulties in analysis and comprehension. As a result, the learners obtain a low rating in the TIMSS.
Moreover, in 2019, TIMSS will also be available as a digital assessment. Newly created assessment items comprise a substantial portion (40 percent) of each TIMSS cycle. The items developed for TIMSS assessed areas of the TIMSS frameworks that have been difficult to measure using

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traditional paper and pencil methods. Tasks call for applying and integrating content knowledge and cognitive capabilities in problem situations that simulate real world contexts and laboratory experiments. In particular, the problem-solving and inquiry tasks require students to solve a problem or follow a scientific line of inquiry. Tasks will assess the learners' knowledge in all areas covered by the previous TIMSS framework, including algebra, data and chance, physics, and chemistry [48]. Furthermore, the kind of test given to the learners such as the traditional paper and pencil methods cannot be a basis of knowledge and capabilities of the learners in numeracy skills. TIMSS is exactly needed by teachers to know how the learners have gone through their competencies such as in Patterns and Algebra, physics and chemistry.

According to Vistro-Yu, C. [49], Patterns, Functions and Algebra extends from simple patterns to basic algebra concepts at the elementary level to functions at the secondary level. Moreover, Patterns, Functions and Algebra should enable students to recognize and describe patterns, relationships, changes among shapes and quantities, use algebraic symbols to represent and analyze mathematical situations and represent and understand quantitative relationships using mathematical models. Particularly, students are expected to use algebraic notation and thinking in relevant contexts to solve mathematical and real-world problems. Moreover, they are required to translate mathematical representations and use equations. More importantly, they should be able to solve equations and inequalities through various methods as well as use basic concepts of functions to describe relationships [50].

Quality education is the need of modern societies. The capacity of an educational enterprise to provide the relevant learning experiences for learners in the dynamic and ever-changing world has driven schools to become more responsive since the 21st century education demands for better preparation of learners in the basic education to be equipped with the necessary knowledge, skills, values and attitudes. If learners in the basic education have a strong foundation for learning, then, when they get to higher education, they will become innovative and competitive, and ultimately, they will become successful contributors for national development [51]. With regard to the NAT ratings per subject, the private schools garnered the highest rating in Filipino as evidenced by the weighted mean of 73.92 (Moving Towards Mastery) while Mathematics emerged as the subject with the lowest mean rating of 57.69 (Moving Towards Mastery). This indicates that the pupils in the private schools perform well in Filipino but relatively weak in Mathematics [52]. This only indicates that the learners need to improve their learning habits towards enhancing their competencies in Elementary Mathematics particularly in Patterns and Algebra, one of the least mastered skills in the said subject. Moreover, based on the qualitative data gathered, private and public schools utilized different interventions to prepare their pupils to take the achievement test. The interventions used by both types of schools comprised of NAT-based parallel test questions, Saturday reviews, and remedial classes [53]. In addition, some schools also prepare different instructional materials and modules in Elementary Mathematics particularly in Patterns and Algebra. Meanwhile, in the public elementary schools, teachers and school principals determine the least mastered and mastered competencies per subject area. This guides them on the target focus of their NAT parallel- based examination. Significantly, these competencies are utilized as the basis for making sample test for reviews. In the same manner, competencies in Elementary Mathematics served as the focus of the remedial classes and review sessions [54].

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The performance of a school in the National Achievement Test and School Achievement Test may be one of the indications that a school ranks high or low compared to other schools in the division, region or in the entire nation. The results of the said achievement tests may also denote the principal's and teachers' competence and significance in preparing the learners in the nest educational ladder and later in building the nation [55].

The main goal of mathematics is to make learners effective problem solvers. Research-based grade level appropriate instructional materials bare therefore indispensable in order to develop the problem-solving skills of learners in the elementary level. The main objective of this study is to determine the effectiveness of developed instructional material on fraction with the use of Algebra as a tool in problem-solving [56]. Researchers on performance of pupils in Mathematics reveal pupils' difficulty in problem-solving and therefore recommend the development of instructional material suited to their needs. Studies on performances of high school and college learners showed a common difficulty on rational numbers. The instructional material herein proposed will fill the gap on problem-solving deficiencies as well as rational number difficulty [57].

A research explored the use of mathematics manipulatives in the teaching today during an age of technology and standardized testing. It looks at the drawbacks and cautions educators as they use math manipulatives in their instruction. It also explores some cognitive concerns as a teacher goes about teaching with math manipulatives. The paper shares many commonly used math manipulatives used in today's classrooms in the USA and around the world [58]. When comparing pre- and post-test findings of teachers' views about teaching with manipulatives, teachers showed more interest in the post-test. This could have been attributed to the fact that the teachers now have more confidence in their use of manipulatives during their instructional lessons. Teacher also showed strong agreement concerning student with manipulatives pre- and post-lessons. Some of the disabling factors teachers in the pre-test in the implementation of manipulatives were lack of confidence and lack of time to practice [59]. Instructional materials refer to resources available to and used by a teacher for instructional purposes. Teachers' use of instructional materials is influenced by the teachers' experiences of the said materials. Teacher determined appropriate material to use with their learners to support the curriculum standards and how they implemented those instructional materials [60].

The studies reviewed dealt with the assessment of the learners' competencies in Elementary Mathematics which coincides with the researcher's present investigation about Patterns and Algebra. According to the result of the TIMSS, most learners are struggling in the four fundamental operations used in problem solving. However, the kind of test given to the learners such as the traditional paper and pencil methods cannot serve as a sole basis of knowledge and capabilities of the learners in numeracy skills. TIMSS is exactly needed by teachers to know how far the learners have gone through their competencies such as in Patterns and Algebra. Conversely, Hensley [61] explained that the paper and pencil tests can be utilized to assess knowledge and skills of the learners while computer-based is used to improve teaching and learning process. Computer can be used in school in the presentation of a new lesson. It can also be used by conducting electronic test. Moreover, in the study of Harris [62], Hauser [63], Sinwell [64] and Bhaird [65], the use of formative test was considerably emphasized. Formative assessment is an informal test conducted by a teacher. It helps them in identifying concepts that the learners find difficult to understand,

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so that adjustments can be made to the lessons accordingly. Likewise, it pertains to different strategies and methods that the teachers may use in the process of evaluating the learners' comprehension. Evidently, formative assessment gives the learners useful information and ideas about their strengths and weaknesses such as in Patterns and Algebra. When learners know they are doing well, they begin to work harder. Similarly, the diagnostic tests measure the learners' understanding of a subject matter. Teachers usually conduct diagnostic tests for Mathematics skills like those intended for the numerates and non-numerates. The results can be utilized as basis for remedial classes in Elementary Mathematics. Apparently, Seashore & Schoenfeld [66] reiterated that instructional materials are the tools used to achieve successful teaching and learning process. These tools can be used to introduce new lessons to the learners. On the other hand, Niss (2002) [67], explained that mathematical competencies are a set of skills and knowledge needed in the development of mathematical literacy of the learners. Clearly, according to Brawner [68], Don [69], Carahher et al. [70] as cited in the research of Apsari [71], the learners truly encountered problems in the teaching and learning of Algebra which include lessons on variables, algebraic expressions, algebraic equations, problem solving among others. Furthermore, it was revealed that the learners have difficulty in recognizing a clear image of letters, numbers and signs. Most of the learners failed to understand the meaning of symbols in the equation when applied to the four fundamental operations especially in the algebraic expressions, algebraic equations and word problems. Reflecting on the scholarly literature and empirical studies presented, it can be made clear that an investigation that will assess the learners' competencies in Patterns and Algebra from Grades IV-VI is certainly fundamental as it will attempt to address the existing gaps of information which the said scholarly works did not specifically investigate.

METHODOLOGY

Adopting the descriptive method of research, the researcher employed quantitative and qualitative data obtained from the teacher-made test to assess the learners' competencies in Patterns and Algebra for Grades IV-VI. Thereafter, the results served as the basis of the proposed instructional enhancement for teachers. The study was conducted in selected public elementary schools in District I, Division of the City Schools-Manila, Philippines. The researcher chose this as the setting of the research because she is currently employed in one of the schools under the said division thereby giving her a wide and convenient access to the schools involved in the study. This research involved a total of 900 Grades IV to Grade VI pupils of the three (3) schools in District I of the Division of City Schools-Manila. There were 300 pupils for each grade level involved in the investigation composed of Grades IV, V and VI respectively. These pupils were enrolled during the School Year 2018-2019. In particular, the fish bowl technique was utilized in the selection of schools composed of small, medium and large categories. Furthermore, the researcher ensured that there were 2 heterogeneous sections for every grade level selected in the said three schools. Overall, a total of 6 sections for every school was involved in the research. The researcher developed teacher-made tests to assess the competencies of the Grades IV-VI learner respondents in Patterns and Algebra. The said tests were crafted based on the competencies and topics outlined in the Curriculum Guide for Grades IV-VI released by the Department of Education (DepEd) which also correspond accordingly with the competencies mentioned in the Trends in International Mathematics and Science Study (TIMSS). Originally, these tests with a total of 60 items for Grade IV and 100 items each for Grades V and VI were

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constructed based on the Table of Specifications (TOS). After the results of the item analysis were finalized, a total of 30 items for Grade IV while 50 items for both Grades V and VI were then subjected for the actual test administration. In addition, a structured interview was conducted among the teacher respondents to solicit information about the instructional strategies employed in their Elementary Mathematics classes specifically in Patterns and Algebra. To ensure the validity of the teacher-made tests intended to assess the learners' competencies in Patterns and Algebra (Grades IV-VI), the researcher consulted experts in Mathematics such as Master Teachers in Mathematics with the degree in Master of Arts in Education major in Mathematics, a professor in College Mathematics with the degree Doctor of Philosophy major in Mathematics, and resource speakers/trainers of the Mathematics Teachers Association of the Philippines (MTAP) to solicit feedback. Likewise, English language teachers were consulted as regards the language and format of the instrument. Item analysis was then performed to ensure that the test items are reliable after the dry run conducted among the Grades IV to VI pupils of District II, Division of the City Schools, Manila. These learners were not included in the actual administration of the assessment test. The Table of Specifications (TOS) enumerating in detail the items embedded in the teacher-made tests was crafted as well to further establish the validity of these instruments.

The actual administration of the tests followed after finalizing the results of the item analysis ensuring that only acceptable items were included in the tool. Likewise, the Interview Guide Questions used to answer the question about the instructional strategies employed by the teachers in Elementary Mathematics specifically in Patterns and Algebra were subjected to content and face validation by the experts in Curriculum and Supervision, Mathematics and English. The researcher first sought the approval of the Schools Division Superintendent (SDS) of the Division of City Schools-Manila to conduct the study in the aforementioned three (3) elementary schools in District I. Likewise, she also requested the approval of the SDS to perform the dry run of the assessment tests to other schools of District II. Results of the dry run were then analyzed and subjected to item analysis followed by their actual administration upon obtaining the approval from the School Principals of the schools involved in the study. In particular, out of the 60-item test in Grade IV, 50 items were found acceptable based on the results of the item analysis. In Grade V, out of the 100-item test, 58 items were acceptable and lastly, for Grade VI, 62 items were declared acceptable out of the 100 items. The Master teachers themselves recommended a total of 30-item test for Grade IV, 50-item test for Grade V and 50-item test for Grade VI for the actual test administration. The researcher conducted the actual test administration among the learners during the fourth grading period of the school year 2018-2019. The interview was conducted too among the teacher respondents to solicit information about their existing instructional strategies in Patterns and Algebra. The results of these assessment tests were then tallied and submitted to the CEU Center for Data Analysis for appropriate statistical processing followed by the corresponding analyses and interpretations of the data obtained. The data gathered in the research were analyzed and interpreted correspondingly using the following statistical procedures: To determine the competencies of the respondents in Patterns and Algebra, the mean and the standard deviation of the raw and percentage scores were utilized. Finally, to determine the mastered and the least mastered skills, the ranking was employed. All the data in this investigation were processed using the Statistical Package for Social Sciences (SPSS) version 21 at the CEU Center for Data Analysis.

FINDINGS

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Based on the data gathered, the following findings are hereby presented:

1. Existing Instructional Strategies Employed by the Elementary Teachers of Mathematics

Results revealed that the Elementary teachers of Mathematics handling Patterns and Algebra for Grades IV, V and VI utilized manipulative tools, group activities, PowerPoint presentations, practice exercises and peer tutoring in the teaching of the said learning area.

2.Assessment of the Elementary Learners' Competencies in Patterns and Algebra

2.1 Performance of the Respondents in Various Competencies in Patterns and Algebra in Grade IV

The respondents need to reinforce their competency in *determining the missing term/s in a sequence of number, letters and figure* as it failed to meet the expectations of the subject. On the contrary, as regards the skill on *finding the missing number in an equation involving properties of operation need a further enhancement,* it appeared to be "not meeting the expectation" of the subject as well.

2.2 Performance of the Respondents in Various Competencies in Patterns and Algebra in Grade V

The respondents performed a little in sequencing which appeared as "fairly satisfactory". However, *solving simple equation involving one or more operations need a further enhancement* which appeared as "did not meet the expectation". Meanwhile, *solving problems that need to reinforce* emerged as the lowest among all the competencies.

2.3 Performance of the Respondents in Various

Competencies in Patterns and Algebra in Grade VI

The respondents satisfactorily perform in *sequencing*. On the contrary, *translating algebraic expressions* needs further enhancement with a verbal interpretation of "did not meet expectation". Meanwhile, *translating algebraic equations* needs to be reinforced as it turned as a skill that "did not meet expectation". Unfavorably, *solving equations/problem* necessitates a further enhancement with a verbal interpretation of "did not meet expectation".

3. Mastered and Least Mastered Competencies in Patterns and Algebra

3.1 Mastered and Least Mastered Competencies of the Respondents in Patterns and Algebra for Grade IV

The respondents obtained a mean percentage of 73.10 with a standard deviation of 27.469 in *finding the missing number in an equation involving properties of operations* thus included among the "least mastered" skills. Meanwhile, the respondents find it too difficult to *determine the missing term in a sequence of numbers* with a mean percentage of 68.50 with a standard deviation of 18.616 interpreted as a "least mastered" competency as well.

3.2 Mastered and Least Mastered Competencies of the Respondents in Patterns and Algebra for Grade V

The respondents demonstrated a slight progress in *sequencing* due to the category of "nearly mastered" competency with a mean of 79.21 and a standard deviation of 15.305. Meanwhile, *solving simple equation involving one or more operations* fell under the category of "least mastered" skills with a mean percentage of 50.222 with a standard deviation of 33.555. Similarly, *solving problem* emerged as another "least mastered" skill as evidenced by the mean percentage of 48.52 with a standard deviation of 25.279.

3.3 Mastered and Least Mastered Competencies of the Respondents in Patterns and Algebra for Grade VI

The respondents demonstrated a little progress in *sequencing* as it fell into the category of "nearly mastered" competency with a mean of 80.7333 with a standard deviation of 16.97201. Meanwhile, *translating algebraic expressions* emerged as a "least mastered" skill as evidenced by the mean

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percentage of 69.1111 with a standard deviation of 24.75346. Moreover, *translating algebraic equations* fell under the category of "least mastered" skill based on the recorded mean percentage of 63.1667 and a standard deviation of 25.71479. Lastly, *solving problems* fell under the category of "least mastered" skills with a mean percentage of 44.3590 with a standard deviation of 17.11209.

4. Proposed Instructional Enhancement for Teachers

Based on the results of the study, a curricular enhancement intended for both teachers and learners and is comprised of specific learning outcomes/competencies, teaching and learning activities, learning resources/materials and assessment was proposed to deal with the competencies that emerged as "least mastered" skills.

Table 1 exhibits the proposed instructional enhancement comprised of the existing and the proposed instructional enhancement.

Table 1. Proposed Instructional Enhancement - Existing Instructional Enhancement and Proposed Instructional Enhancement

Existing Instructional Enhancement	Proposed Instructional Enhancement
Grade IV	Grade IV
-Use of manipulative tools -Group activities -PowerPoint presentation	-Use of manipulatives such as letters, numbers and symbols and use of concrete, pictorial and abstract -Cooperative learning -PowerPoint presentation with animation -Compilation of practice exercises
Grade V	Grade V
-PowerPoint presentation - Group activity -Practice exercises	-PowerPoint presentation with animation -Cooperative learning -Compilation of practice exercises -Use of manipulatives such as letters, numbers and symbols and use of concrete, pictorial and abstract
Grade VI	Grade VI
-PowerPoint presentation - Group activities -Use of manipulatives -Peer tutoring	-PowerPoint presentation with animation -Cooperative learning -Use of manipulatives such as letters, numbers and symbols and use of concrete, pictorial and abstract -Compilation of practice exercises

CONCLUSIONS

Based on the findings, the researcher hereby concludes the following:

1. The Elementary teachers of Mathematics handling Patterns and Algebra consider manipulative tools, group activities, PowerPoint presentations, practice exercises and peer tutoring as useful pedagogical

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strategies in the teaching of the said learning area.

2. The Grade IV learners encounter difficulties in *finding the missing number in an equation involving properties of operations* and in *determining the missing term/s in a sequence of numbers*

3. The Grade V learners perform fairly satisfactory in *sequencing* while they exhibit poor performance in *solving simple equations involving one or more operations and solving problem.*

4. The Grade VI learners finds *sequencing* a little challenging but considers *translating algebraic expression, translating algebraic equations and solving equation/problems* too difficult.

5. A proposed instructional enhancement may help the teachers in enhancing the least mastered skills of the learners in Patterns and Algebra among Grades IV-VI learners.

RECOMMENDATIONS

Based on the findings and conclusions, the following are hereby recommended:

1. The Mathematics Teachers must participate in seminars, trainings and conferences on various topics on Patterns and Algebra specifically on the areas that the learners demonstrate weak performance.

2. Academic intervention programs should be conducted among Grades IV-VI Mathematics learners in Patterns and Algebra during opposite sessions in terms of:

A. Remedial Instruction

B. Practice exercises according to competencies

C. One-on-one tutoring among classmates

Fast learner ► Slow learner

3. Further research can be undertaken by Mathematics Teachers in Patterns and Algebra to discover the most updated teaching approaches, methods, strategies and techniques to address the competencies that the pupils find difficult or too challenging.

4. The proposed instructional enhancement in Patterns and Algebra must be implemented by the Mathematics teachers.

5. Mathematics teachers may develop practice exercises according to the competencies in Patterns and Algebra for Grades IV- VI:

- 5.1 Grade IV - 10 exercises
- 5.2 Grades V - 20 exercises
- 5.3 Grades VI - 30 exercises

6. Interactive strategies integrating 21st technologies can be designed specifically in teaching Patterns and Algebra.

7. Teachers in Mathematics particularly in Patterns and Algebra can keep a quiz compilation for use during review and drill exercises.

8. Lesson plans focused on differentiated instruction in Patterns and Algebra may be crafted.

9. Frequent testing must be conducted to address the learners' difficulties in Patterns and Algebra.

10.Lessons to address the learners' difficulties must be enhanced and checked by the school administrators concerned:

- 10.1 Master Teachers
- 10.2 School Principals
- 10.3 Public Schools District Supervisors/ Education Program Supervisors

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EPIFANIA V. TABBADA, LPT, Ph.D. is the present ICCT Colleges Foundation Academic Consultant of the College of Education. At the same time is a part time lecturer at the Graduate School of Centro Escolar University. She served as Dean of the College of Education and Director of the Center of Excellence at the Technological Institute of the Philippines for eight years, after retiring from the Philippine Normal University where she served as Acting Dean of the Graduate School as her last assignment. She has been awarded as Outstanding teacher of Metro Bank in 1997 and Achievement Award by the National Research Council of the Philippines in 2003, where she served as Chair of Division I. She was also awarded as Distinguished Alumni of the Philippine Normal University and Araullo High School. She served as secretary of the Catholic Women's League of Archdiocese of Manila and board member. She served as International Consultant under the Asia Foundation in Indonesia, a Book writer/ consultant in Cambodia as Curriculum consultant under Asia Development Bank projects. She also conducted several training programs at international, national and institutional levels in Technology and Livelihood Education, Curriculum development and Home Economics both in the Elementary and Secondary. She graduated with Bachelor of Science in Elementary Education from Philippine Normal College (now Philippine Normal University), Philippines where she earned her Master of Arts Degree. She finished her Doctor of Philosophy (Ph.D.) major in Home Economics Educational Curriculum at the University of Illinois in the United States of America.

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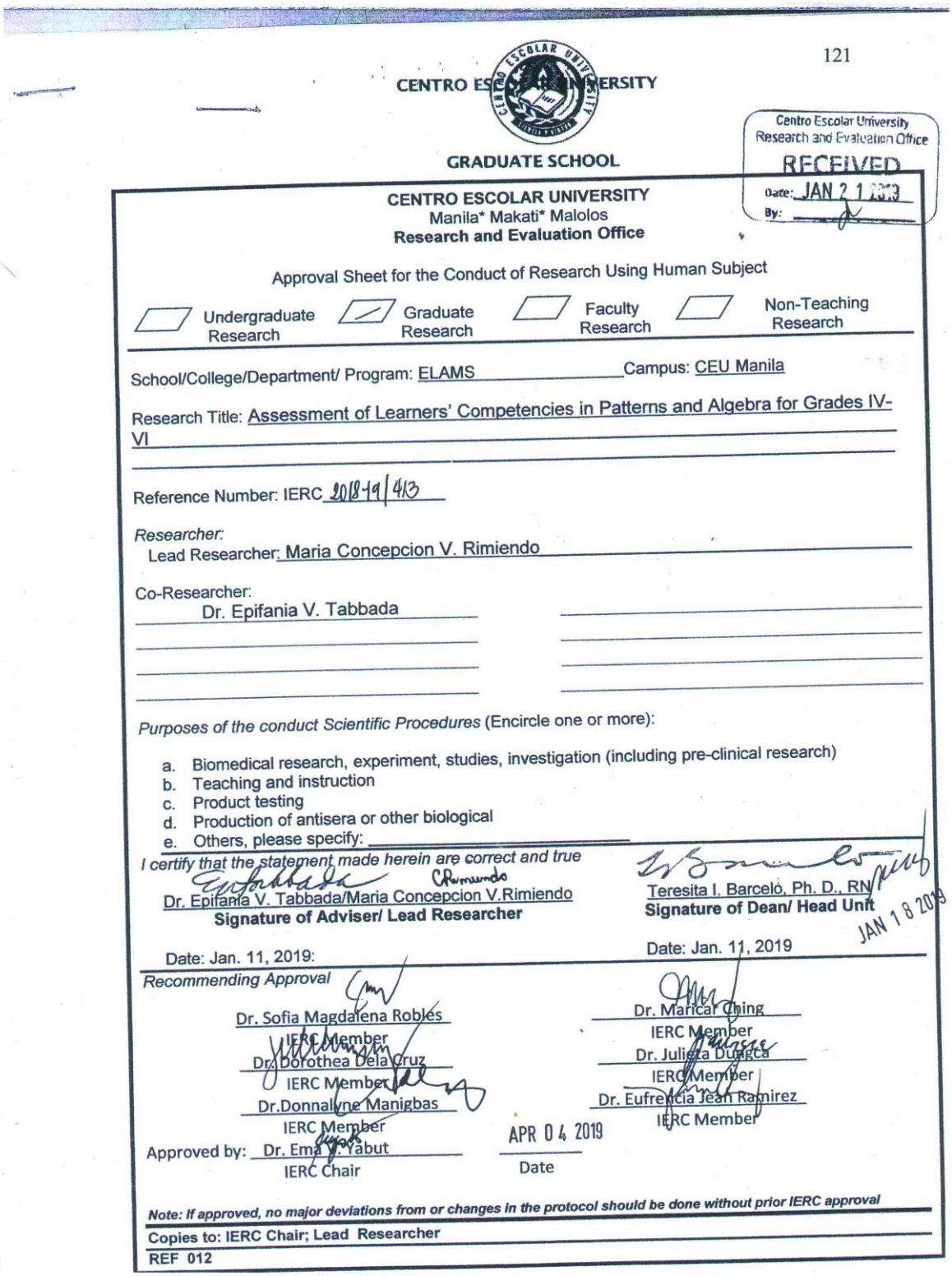

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CENTRO ESCOLAR UNIVERSITY

GRADUATE SCHOOL

Centro Escolar University
Research and Evaluation Office
RECEIVED
Date: JAN 2 1 2019
By:

CENTRO ESCOLAR UNIVERSITY
Manila* Makati* Malolos
Research and Evaluation Office

Approval Sheet for the Conduct of Research Using Human Subject

☐ Undergraduate Research ☑ Graduate Research ☐ Faculty Research ☐ Non-Teaching Research

School/College/Department/ Program: ELAMS Campus: CEU Manila

Research Title: Assessment of Learners' Competencies in Patterns and Algebra for Grades IV-VI

Reference Number: IERC 2018-19/413

Researcher:
Lead Researcher: Maria Concepcion V. Rimiendo

Co-Researcher:
Dr. Epifania V. Tabbada

Purposes of the conduct Scientific Procedures (Encircle one or more):

a. Biomedical research, experiment, studies, investigation (including pre-clinical research)
b. Teaching and instruction
c. Product testing
d. Production of antisera or other biological
e. Others, please specify: _____

I certify that the statement made herein are correct and true

Dr. Epifania V. Tabbada/Maria Concepcion V.Rimiendo
Signature of Adviser/ Lead Researcher

Date: Jan. 11, 2019:

Teresita I. Barcelo, Ph. D., RN
Signature of Dean/ Head Unit

JAN 18 2019

Date: Jan. 11, 2019

Recommending Approval

Dr. Sofia Magdalena Robles
IERC Member

Dr. Dorothea Dela Cruz
IERC Member

Dr. Donnalyne Manigbas
IERC Member

Dr. Marican Ching
IERC Member

Dr. Julieza Dungca
IERC Member

Dr. Eufrencia Jean Ramirez
IERC Member

Approved by: Dr. Ema V. Yabut
IERC Chair

APR 04 2019
Date

Note: If approved, no major deviations from or changes in the protocol should be done without prior IERC approval

Copies to: IERC Chair; Lead Researcher

REF 012

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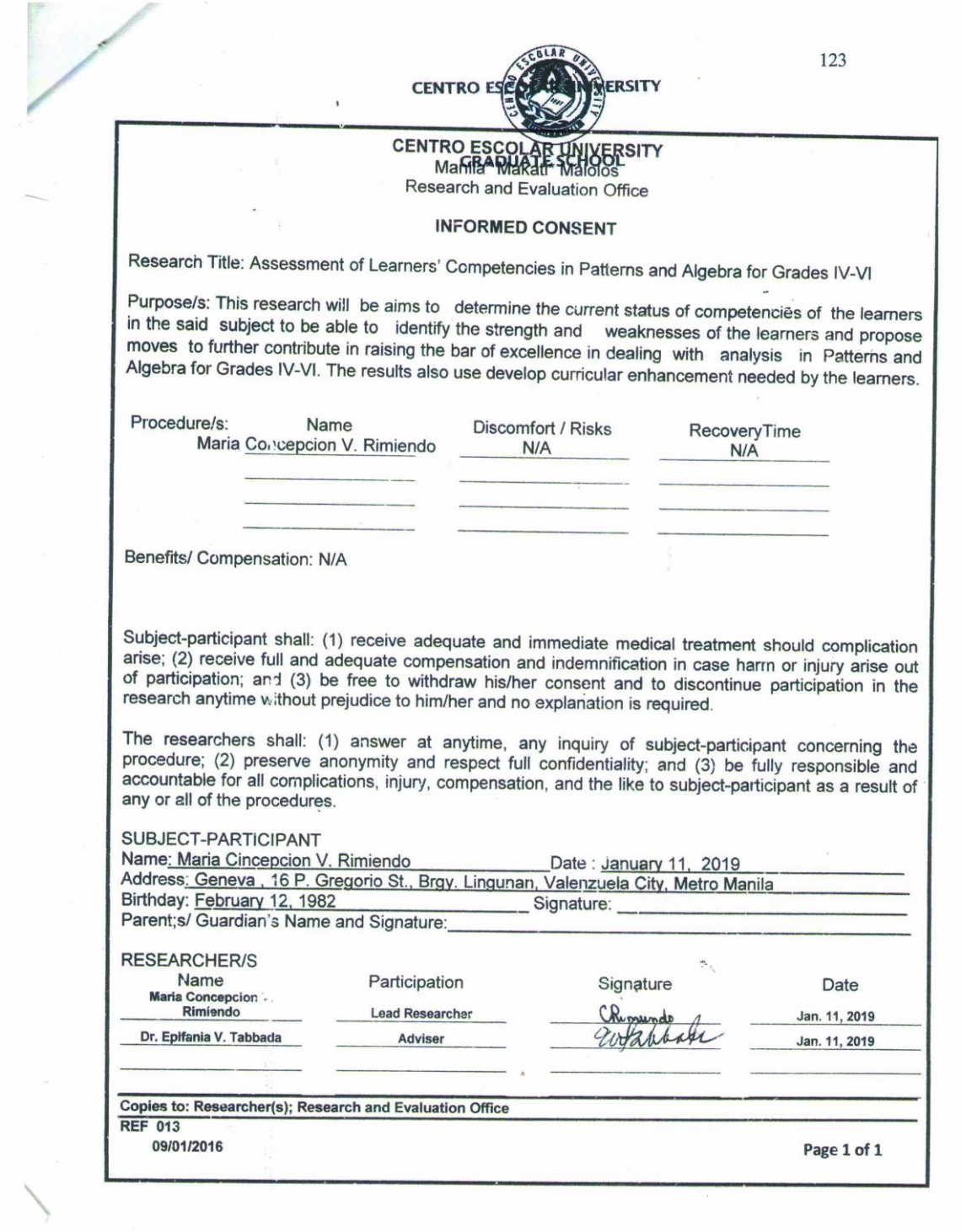

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CENTRO ESCOLAR UNIVERSITY
GRADUATE SCHOOL
Manila Makati Malolos
Research and Evaluation Office

INFORMED CONSENT

Research Title: Assessment of Learners' Competencies in Patterns and Algebra for Grades IV-VI

Purpose/s: This research will be aims to determine the current status of competencies of the learners in the said subject to be able to identify the strength and weaknesses of the learners and propose moves to further contribute in raising the bar of excellence in dealing with analysis in Patterns and Algebra for Grades IV-VI. The results also use develop curricular enhancement needed by the learners.

Procedure/s:	Name	Discomfort / Risks	RecoveryTime
	Maria Concepcion V. Rimiendo	N/A	N/A

Benefits/ Compensation: N/A

Subject-participant shall: (1) receive adequate and immediate medical treatment should complication arise; (2) receive full and adequate compensation and indemnification in case harm or injury arise out of participation; and (3) be free to withdraw his/her consent and to discontinue participation in the research anytime without prejudice to him/her and no explanation is required.

The researchers shall: (1) answer at anytime, any inquiry of subject-participant concerning the procedure; (2) preserve anonymity and respect full confidentiality; and (3) be fully responsible and accountable for all complications, injury, compensation, and the like to subject-participant as a result of any or all of the procedures.

SUBJECT-PARTICIPANT
Name: Maria Cincepcion V. Rimiendo Date : January 11, 2019
Address: Geneva , 16 P. Gregorio St., Brgy. Lingunan, Valenzuela City, Metro Manila
Birthday: February 12, 1982 Signature:
Parent;s/ Guardian's Name and Signature:

RESEARCHER/S

Name	Participation	Signature	Date
Maria Concepcion Rimiendo	Lead Researcher		Jan. 11, 2019
Dr. Epifania V. Tabbada	Adviser		Jan. 11, 2019

Copies to: Researcher(s); Research and Evaluation Office
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09/01/2016
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Republic of the Philippines
Department of Education
National Capital Region
DIVISION OF CITY SCHOOLS
Manila

January 24, 2019

THE PRINCIPALS CONCERNED
Manila

Sirs/Mesdames,

Permission to visit school this Division is hereby granted to:

Names of Researcher
Maria Concepcion V. Rimiendo

Centro Escolar University
School/University

To conduct study "Assessment of Learners' Competencies in Patterns and Algebra For Grades IV-VI"
Purpose

Note: 1. The conduct of the study shall be in consultation with the Principal/s concerned.
(Proper scheduling is requested.)

2. Time-on-Task policy of DepEd shall be adhered to.

3. Resources of the school shall not be used for this purpose.

4. Confidentiality of the respondents is ensured.

5. This Office requests a copy of the final research output at the end of the term of study.

Kindly extend to her the usual cooperation and hospitality.

Thank you.

Very truly yours,

For the Superintendent:

PEDRO M. ARAO
Assistant Schools Division Superintendent

Schools Concerned:
- District I Public Elementary Schools